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3D Face Recognition Integrated With Hand Gestures For HCI

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ABSTRACT

One of the most appalling features of recognition is analyzing the functionality of human acumen. The main goal is to create a system which can authenticate user via facial detection, recognize specific human gestures and use them to convey information or for device control. To achieve this, an animated 3D model is generated for each user based on 17 automatically located landmark points on the face. 3D face detection is implemented along with hand gesture recognition which can be used for device control. The use of hand gestures provides an attractive alternative to cumbersome interface devices for human-computer interaction (HCI). This paper also proposes a method to recognize different hand gestures and use them in different environments. Using camera the images of hand actions are captured and the image is transferred to the microcontroller which controls the interface of appliances.

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INTRODUCTION

Face Recognition and Hand Gestures as a tool is growing in popularity amongst researchers from a whole host of different disciplines and have the potential to become an even more important component in future perceptual user interfaces. These techniques are used in Artificial Intelligence, cognitive learning, Image Processing, human-computer interaction, Security, medical research, and other areas. There are very few techniques that have been proposed for scenes where the camera and the head could move independently to recognize Face and capture Hand Gestures. Face Recognition is done in 3-D through camera. Hand Gestures is done through motion capture of static Images using Sensors.

The Virtual Environment will be one of the requisites of the future to create a Smart Environment. Controlling devices through Face Recognition, eye gestures, hand gestures, motion controls etc., could pave way for such smart homes, Virtual trainings, Secured Processing etc. In Real World, with ever increasing Stress, this technology will increase the flexibility of stress free world. Smart Environments can be empowered with face recognition integrated to Hand gestures that could be used to automatically evolve the System. One of the important areas of application for face recognition is dynamic expression detection for High level Security. Cyber thefts can be reduced and privacy of data is preserved immutability.

As 3D sensing technologies advance and the acquisitiondevices become more accurate and less expensive, the utilization of range data instead of / together with the texture data broadens. Consequently, in FRVT 2006 (Huang, D., *et al*, 2010), an orderofmagnitude improvement in recognition performance was achieved over the FRVT 2002 for 3D face images, with FRR of 0.01 at a FAR of 0.001. Similar results were also achieved with high resolution still images under controlled illumination.

This architecture diagram clearly illustrates the detection of face .In the first phase, the face is detected through HOG and Local Binary Pattern. The Second Phase is Recognition of face through Landmarking and Thin Plate SP line. The Third Phase is feature Extraction and finally comparision of Image.

This Architecture explains the Hand gesture Integration with Face Recognition. The Sensor detects the gestures and generates the corresponding signals to microcontroller. The Load in Microcontroller processes the signals and initiates the specified Operations.

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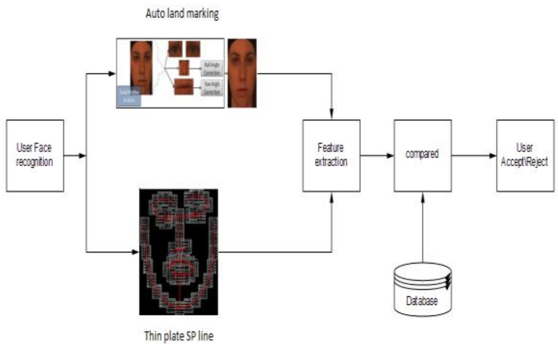
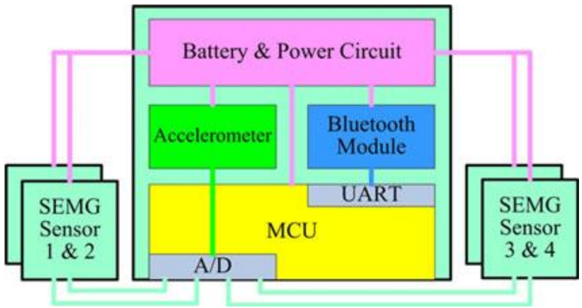
Architecture diagram:





I. Data Processing:

3D scanner outputs are mostly noisy. The purposes of the preprocessing step can be listed as:

1. To extract the face region (same in 2D and 3D images); 2. To eliminate spikes/holes introduced by the sensor;

3. To smooth the 3D surface.

Firstly, adopting the method proposed in the nose tipis detected: For each row, the position with the maximum z value is found and then for each column, the number of these positions is counted to create a histogram. The peak of this histogram is chosen as the column for the position of the vertical midline, and the maximum point of this contour isidentified as the nose tip. Using a sphere of radius 80mm and centered 10mm away from the nose tip in +z direction, the facial surface is cropped.

Next, the existing spikes are removed by thresholding. Spikes are frequent with laser scanners, especially in the eye region. After the vertices that are detected as spikes are deleted, they leave holes on the surface. Together with other already existing holes (again usually around the eyes andeyebrows), they are filled by applying linear interpolation

IV. *Landmarking And Thin Plate Sp Line:*

Firstly, facial midline (vertical profile) analysis is done and 5 fiducial points on that midline are detected. Based onthat information; face is split into sub-regions for the coarselocalization of eyes, nose and lips. After that, further analysisis done inside these extracted sub-regions to detect the points of interest. For those regions with non-informative texture (like nose), 3D data is analyzed. On the other hand for theregions with noisy surface and/or distinctive color information(like eyes), 2D data is utilized. As a result, 17 facial interestpoints are detected in total, consisting of 4 points for each eye, 5 points for the nose and 4 points for the lips.

Vertical Profile Analysis:

The analysis done on the vertical profile constitutes the backbone of the whole system. It starts with the extraction of the facial midline and for this purpose; the nose tip is detected as explained previously. The nose tip position allows us to search for the eyes in the upper half of the face in order to approximately locate irises, so that the roll angle of the face can be corrected before any further processing.

Eye Regions:

The 3D surface around the eyes tends tobe noisy because of the reflective properties of the sclera,the pupil and the eyelashes. On the other hand, its texturecarries highly descriptive information about the shape of the eye. For that reason, 2D data is preferred and utilized to detect the points of interest around the eyes, namely the iris center, the inner and outer eye corners and the upper and the lower borders of the iris.

Thin Plate Spline Warping:

As the name indicates, the TPS method is based on a physical analogy to how a thin sheet of metal bends under a force exerted on the constraint points.

The TPS method was made popular by Fred L. Bookstein in 1989 in the context of biomedical image analysis. For the 3D surfaces S and T, and a set of corresponding points (point pairs) on each surface, Pi and Mirespectively, the TPS algorithm computes an interpolation function f(x,y) to compute T', which approximates T by warping S:

T
_ = {_*x*_
, *y*_
, *z*__ |∀ *(x, y, z)* ∈ *S*,
x
_ = *x*; *y*
_ = *y*; *z*
_ = *z* + *f (xy)*} (2)

*f(x, y) = a*1 + *axx* + *ay y* +_*wiU(|Pi* −*(x, y)|)* (3)

with U(.), the kernel function, expressed as:

U (r)= *r* 2 ln *r* 2, *r* = _*x*2+*y*2 (4)

In the interpolation function f(x,y), the wi, i∈{ 1,2,...n} are the weights. As given in (3), the interpolation function consists of two distinct parts: An affine part (a1+axx+ayy) which accounts for the affine transformation necessary forthe surface to match the constraint points and a warping part (_wiU(|Pi-(x,y)|)).

II. *Hand Gesture Recognition:*

The algorithms described here are implemented in the gesture recognitionmodule of the interaction application program. Accurate recognitionand fast response times are the basic requirements for algorithms running on mobile devices with limited computational resources.

BecauseSEMGsignals andACCsignals have their own advantages and disadvantages, small-scale and large-scale gestures are separated and processed using different schemes . Small-scale gestures are classified based only on SEMG signals, and large-scale gestures based on the fusion of SEMGandACC signals.

Segmentation aims to find the starting and end points of each motionfrom the signal stream. The recorded signals between these points are named the active segment. In (Chong, M.K., 2010) and we demonstrated the feasibility of SEMG-based segmentation. ACC signals were segmented synchronously with the SEMG signal. However, ACC and SEMG signals are completely different on waveform and physical meaning. In mobile practice, SEMG active segments (SASs) are seldom aligned with corresponding ACC active segments (AASs), because it is difficult for a user (especially a novice) to ensure synchronization betweenarm waving and hand grasping. Therefore, a new method to segment

ACC signals and SEMG signals separately is proposed to achieve betterperformance. Each movement corresponds to an AAS and an SAS,without strict synchronization. For ACC signal segmentation, eachSAS is utilized to estimate a candidate ACC active segment (CAAS).

The ACC segmentation algorithm only needs to process signals aroundCAAS to locate an AAS. ACC segmentation, therefore, becomes much easier because most artifacts are ruled out.

III. *Conclusion And Future Work:*

Based on the assumption of a fully-controlled environmentfor enrollment, a face recogn-ition framework is proposed inwhich it is integrated with hand gestures to provide a simple and smart environment. Depending upon the authentication success, the user is forwarded to the smart environment where he can control the devices through hand gestures. This system aims to provide a secure and simplistic way to interact with computers and devices.

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